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Academic Year:2021-22	**Department : FE**
Term – I	**Name of Course : ENGINEERING PHYSICS (107002)**

Name of Course : ENGINEERING PHYSICS (107002)

Examination Pattern : INSEM 30 m ENDSEM 70M

Class : FE ABCD

Division : A&C

Unit No. : 5

Faculty Name : DR VANDANA B PATIL

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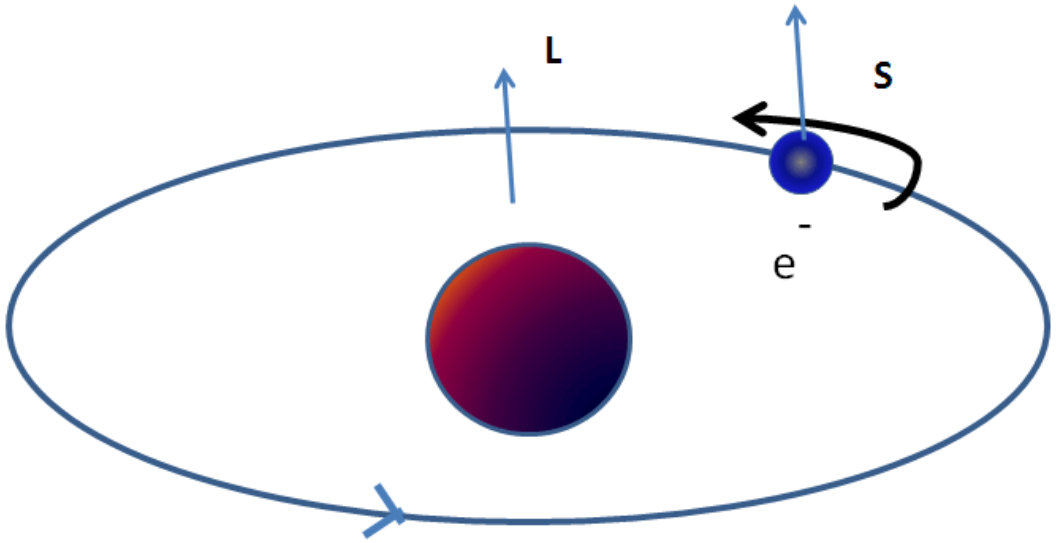

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Magnetism

- Magnetism: Study of Effect of magnet and its effects
- Origin of magnet: Every rotating / spinning charged particle develops magnetic effect.
- **Origin of Magnetism**. **Magnetism** originates from the spin and orbital magnetic moment of an electron. The orbital motion of an electron around the nucleus is analogous to the current in a loop of wire.

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Some terms in Magnetism

❖**Magnetic field strength: (H) –** The magnitude of the force experienced by unit North pole at any point in the field is called as The Strength of the Magnetic Field at that point

❖Units MKS N/Am or W/m^2

❖CGS: Gauss or oersted

❖**Magnetic Induction or Flux Density (B):** It is the number of hypothetical induction lines passing normally through unit area. **Unit: Tesla (T) or weber / m^2**

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Intensity of magnetization I

- It measures the degree of magnetisation of a magnetised specimen and is defined as magnetic moment per unit volume **I =**
(Magnetic moment (M) / Volume
- **Magnetic Susceptibility $\varkappa$ = I / H**
- **Magnetic permeability μ = B / H**
- **For free space it is 4π x** 10^{--7} Henry / m

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Types of magnetic material

Diamagnetic materials

Properties

- No permanent dipole or magnetic moment is present.
- The external magnetic field produces induced magnetic moment.
- Induced magnetic moment is always in opposite direction of the applied magnetic field.
- So magnetic induction in the specimen decreases.
- Magnetic susceptibility is small and negative.
- Repels magnetic lines of force.

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Types of magnetic material

Paramagnetic materials

Properties

- Possess permanent dipoles.
- In the absence of external mag. Field all dipoles are randomly oriented so net magnetic moment is zero.
- In presence of magnetic field the material gets feebly magnetized.
- i.e. the material allows magnetic lines of force to pass through it.
- The orientation of magnetic dipoles depends on temperature and applied field.
- Susceptibility is small and positive.

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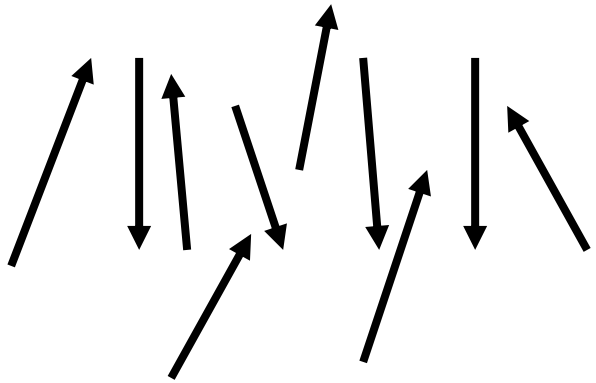
Types of magnetic material

Properties



Susceptibility is independent of applied mag. field & depends on temperature
C is Curie constant
Spin alignment is random.
The magnetic dipoles do not interact.
These materials are used in lasers.
Paramagnetic property of oxygen is used in NMR technique for medical diagnose.
Examples: alkali metals (Li, Na, K, Rb), transition metals, Al, Pt, Mn, Cr etc.

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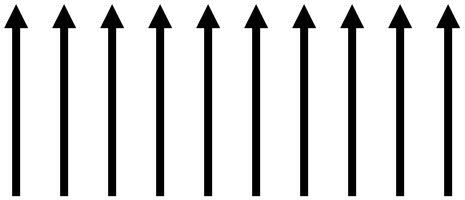
Types of magnetic material

Feromagnetic materials

Properties

- Possess net magnetic moment
- Possess spontaneous magnetization.
- Material shows magnetic properties even in the absence of external magnetic field.
- Spontaneous magnetization is because of interaction between dipoles called EXCHANGE COUPLING.
- When placed in external mag. field it strongly attracts magnetic lines of force.
- All spins are aligned parallel & in same direction



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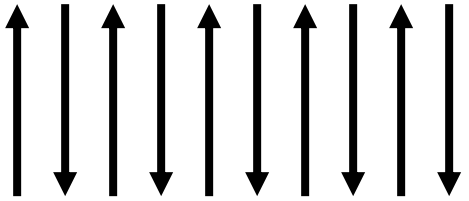
Types of magnetic material

Antiferromagnetic Material Properties

- The spin alignment is in antiparallel manner.
- So net magnetic moment is zero.
- Susceptibility is small and positive.
- Initially susceptibility increases with increase in temperature and beyond Neel temperature the susceptibility decreases with temperature.
- At Neel temperature susceptibility is maximum.
- Examples: FeO, MnO, Cr_2O_3 and salts of transition elements.



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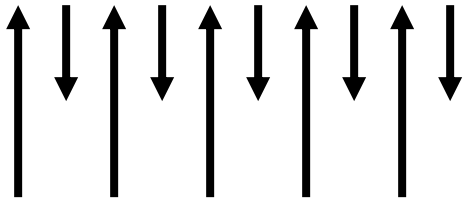
Types of magnetic material

Ferrimagnetic Materials

Properties

Special type of antiferromagnetic material.
The spin alignment is antiparallel but different magnitude.
So they possess net magnetic moment.
Also called ferrites.
Susceptibility is very large and positive.
Examples: ferrous ferrite, nickle ferrite



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Types of magnetic material

Diamagnetic materials

Properties

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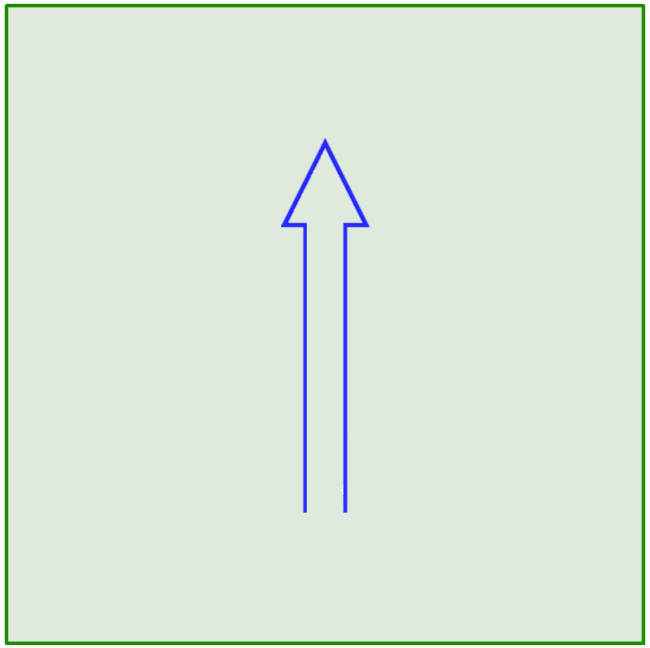
- So magnetic induction in the specimen decreases.
- Magnetic susceptibility is small and negative.
- Repels magnetic lines of force.

Magnetic Domains

Two ways for aligning of magnetic domains:

1. Growth of favorably oriented domains (initially)
2. Rotation of domains (finally)

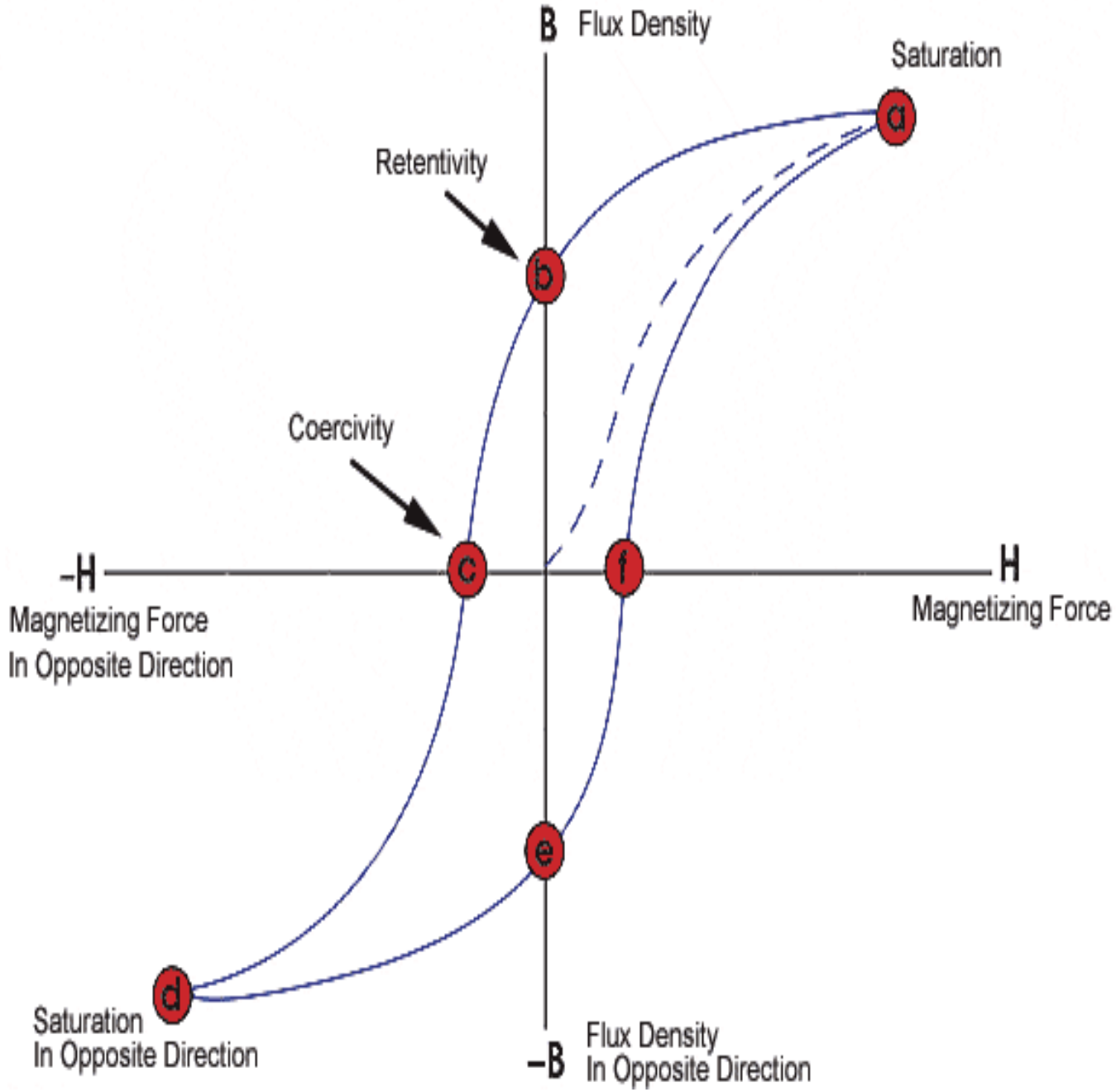
Magnetic domains

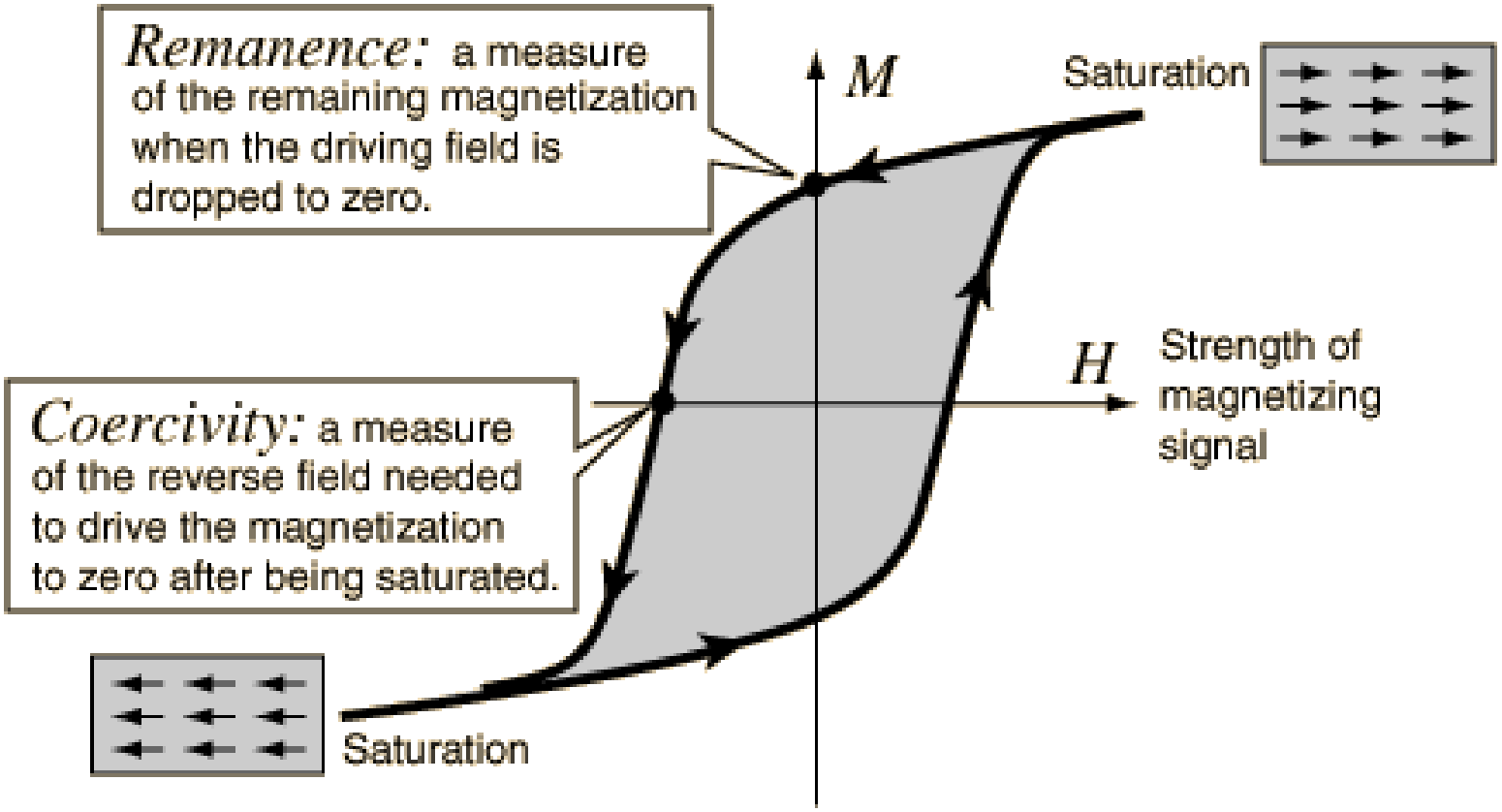


- Applying very strong fields can saturate magnetization by creating single domain

Hysteresis Curve

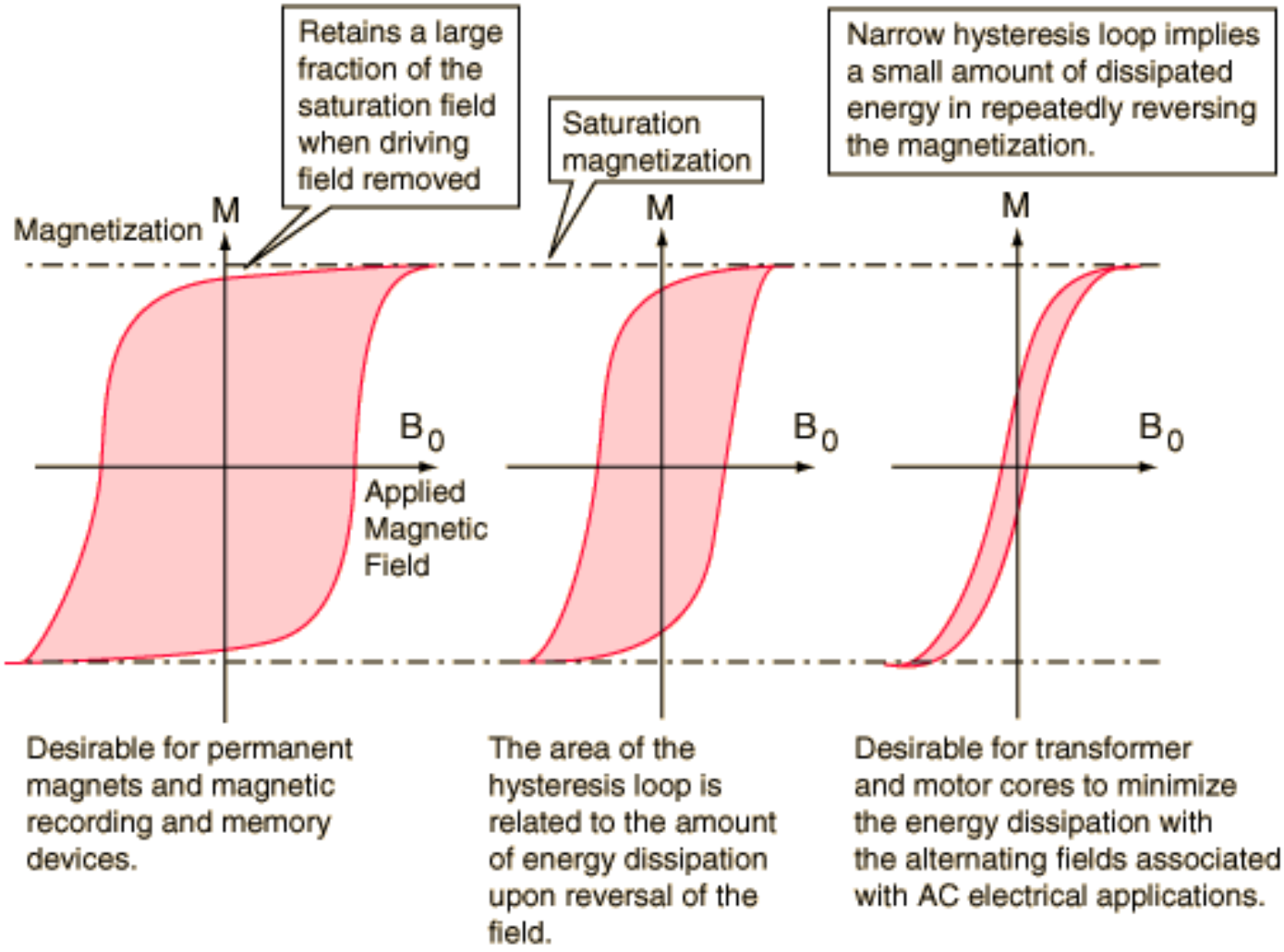
- Means lagging or retarding of an effect behind the cause of the effect.
- Here effect is B & cause of the effect is H.
- Also called B H curve.
- Hysteresis in magnetic materials means lagging of magnetic induction (B) or magnetization (M) behind the magnetizing field (H).


B Flux Density
Saturation
a
Retentivity
b
Coercivity
c
f
-H
Magnetizing Force
In Opposite Direction
H
Magnetizing Force
e
d
Saturation
In Opposite Direction
-B
Flux Density
In Opposite Direction



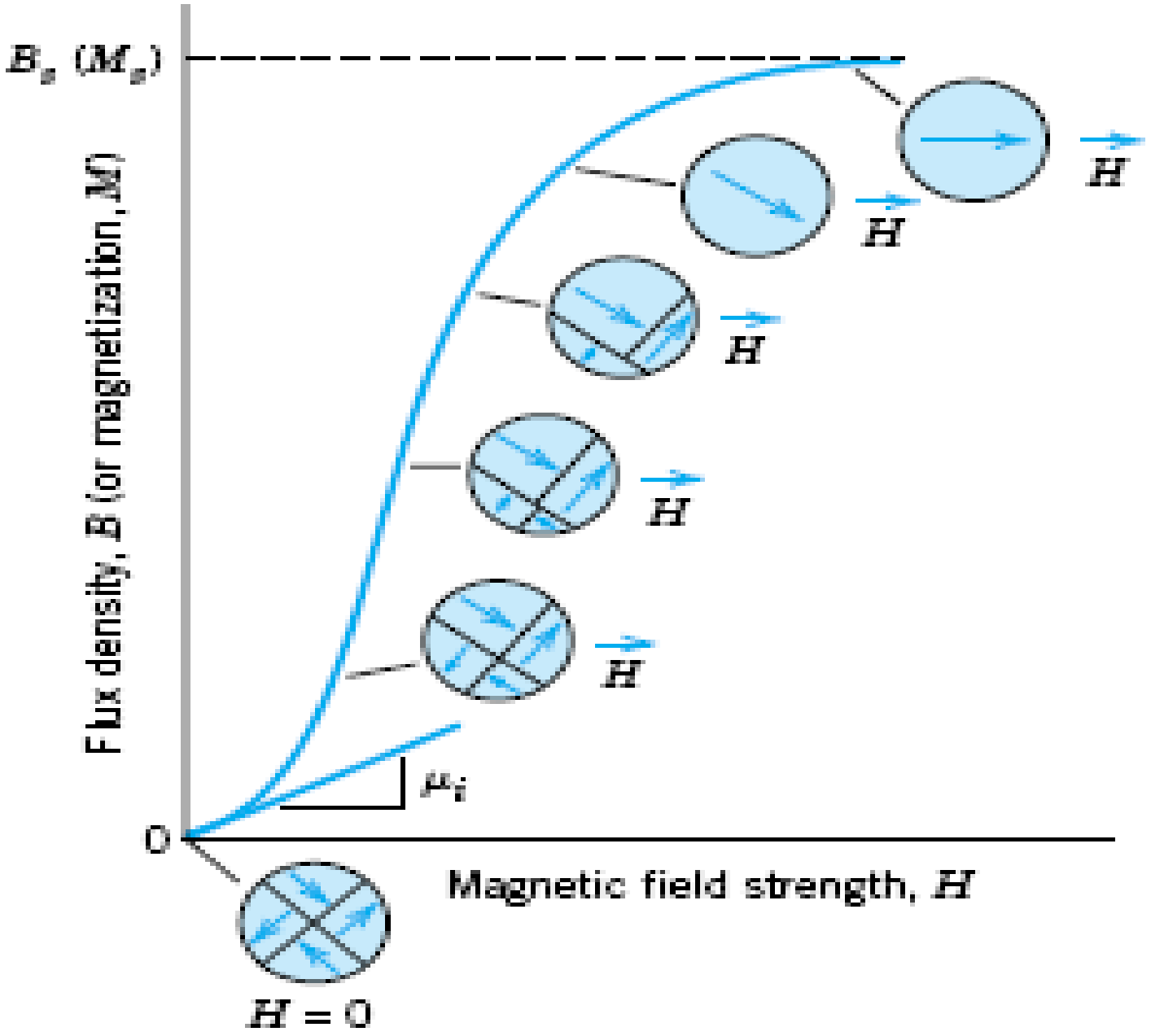
remanent magnetization = M_0

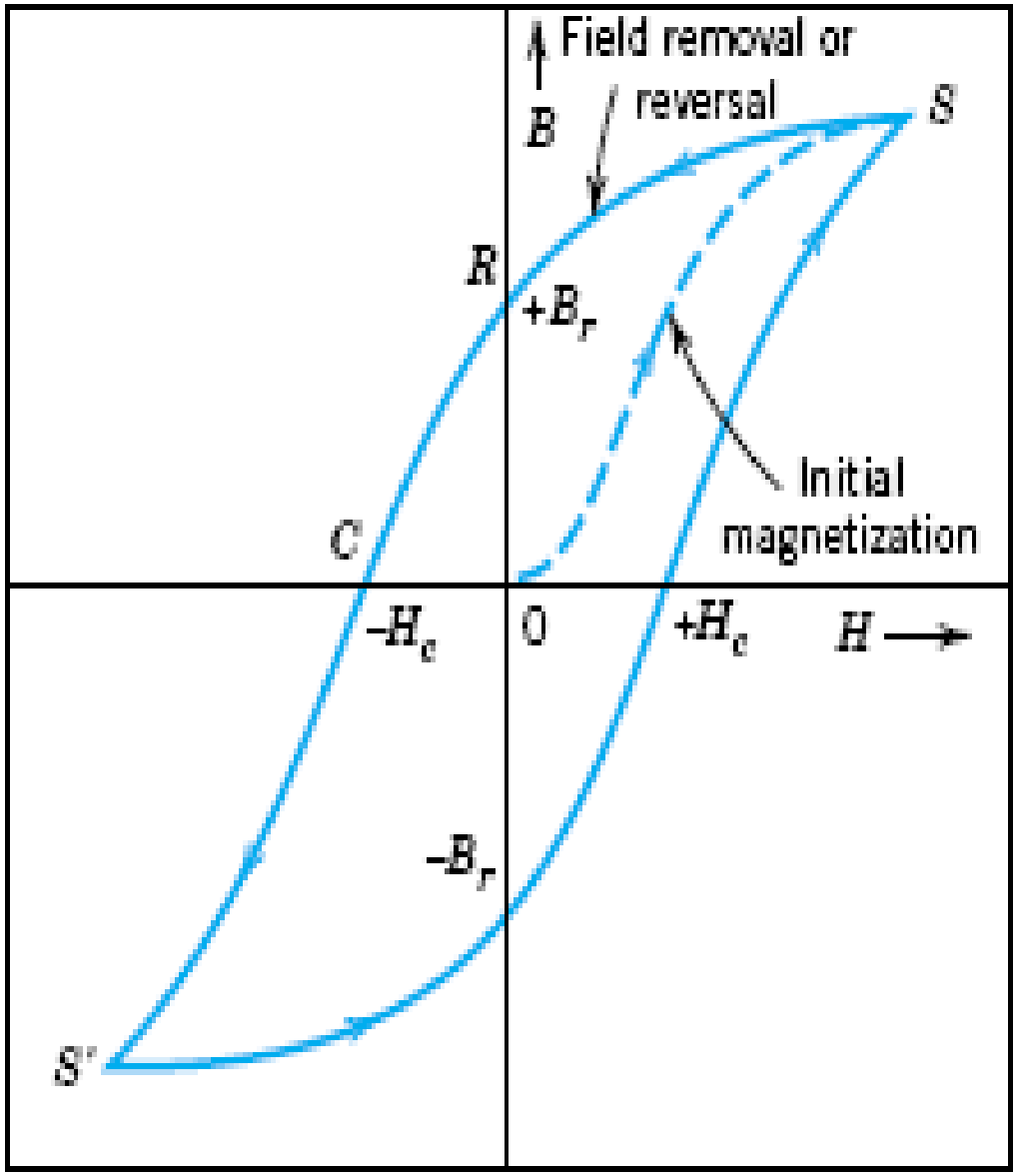
coercivity = H_c



"hard" ferromagnetic material has a large M_0 and large H_c.

"soft" ferromagnetic material has both a small M_0 and H_c.


B_s (M_s)
Flux density, B (or magnetization, M)
0
μ_i
$\vec{H}$
$\vec{H}$
$\vec{H}$
$\vec{H}$
$\vec{H}$
$H = 0$
Magnetic field strength, H


Field removal or
reversal
B
S
R
$+B_r$
Initial
magnetization
C
$-H_c$
0
$+H_c$
H
$-B_r$
S'